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Original communication

A review of suspected cases of driving under the influence of drugs (DUID) involved in traffic accidents in Istanbul (Turkey)☆

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ABSTRACT

Nowadays traffic accidents, which have high mortality and morbidity, are an important public health problem. The association between the use of alcohol and/or drugs by drivers and the increased risk of traffic accidents with a high risk of death and injury has been well described in the literature.

This study aimed to review the incidence of cases of driving under the influence of drugs (DUID) among all cases of driving under the influence (DUI) of alcohol and/or other drugs involved in traffic accidents and to evaluate the type of the psychoactive drugs (with or without alcohol) detected in blood samples in Istanbul and its surrounding area. This study is the first investigation on the subject of DUID cases in Turkey.

The reports of the Istanbul Toxicology Department of the Council of Forensic Medicine (Turkey) on suspected DUID cases involved in traffic accidents between 1 July 2010 and 30 June 2011 were retrospectively reviewed for alcohol and/or drug use.

Alcohol analysis was requested in 4274 suspected DUI cases, whereas drug along with alcohol analysis was requested in only 91. The rate of suspected DUID cases ($n = 91$) among the suspected DUI cases ($n = 4274$) was only 2.1% and in this study, we evaluated only the DUID cases in detail. Alcohol was present in 44% of suspected DUID cases. Psychoactive drugs were present in 15.4% of cases. The incidence among 46 confirmed DUID cases was found to be 17.4% for cannabis, 8.7% for benzodiazepines, 4.3% for barbiturates, 4.3% for antidepressants, 2.2% for cocaine and 2.2% for amphetamines.

Although there is a zero-tolerance approach for DUID in the Turkish regulations, it is not well recognised and not inspected by police and legal authorities who are responsible for taking measures in traffic accidents and for routine traffic controls in Turkey. It is concluded that psychoactive drugs should be checked as well as alcohol in all traffic accident cases and roadside controls.

1. Introduction

Traffic accidents, which cause high mortality and morbidity rates, are an important public health-related problem at global, regional and national levels. According to the report of the World Health Organization it is estimated that road traffic accidents will rise to become the fifth leading cause of death by 2030, even though it was only the ninth leading cause of death in 2004.[1] Driving under the influence of alcohol (DUIA) and/or driving under the influence drugs (DUID, in other words, DUI-drug or drugged driving) is one the most significant reasons for this serious problem.[2,3]

In various studies, it has been shown that there is an association between the use of drugs by drivers and an increased risk of traffic accidents that, in turn lead to an increased risk of death and

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Table 1
The list of drugs screened in CEDIA and LC/MS/MS.

Group	CEDIA	LC/MS/MS	Group	CEDIA	LC/MS/MS
Antipsychotics	–	Clozapine, olanzapine, quetiapine, promazine, risperidone	Opioids	Buprenorphine, codeine, dihydrocodeine, heroin, hydrocodone, hydromorphone, methadone, morphine, morphine-3-glucuronide, morphine-6-glucuronide, 6-monoacetylmorphine	Buprenorphine, codeine, dihydrocodeine, heroin, hydrocodone, hydromorphone, methadone, morphine, morphine-3-glucuronide, morphine-6-glucuronide, pethidine, 6-monoacetylmorphine, tramadol
Barbiturates	Amobarbital, aprobarbital, butabarbital, butalbital, cyclopentobarbital, pentobarbital, phenobarbital, secobarbital, talbutal	Amobarbital, aprobarbital, butabarbital, butalbital, cyclopentobarbital, pentobarbital, phenobarbital, secobarbital, talbutal, thiopental			
Benzodiazepines	Alpha-hydroxyalprazolam, alpha-hydroxytriazolam, alprazolam, alprazolam glucuronide, bromazepem, clonazepam, diazepam, flurazepam, lorazepam, lorazepam glucuronide, medazepam, midazolam, oxazepam glucuronide, 7-amino-clonazepam, 7-amino-flunitrazepam, 7-amino-nitrazepam, temazepam, temazepam glucuronide, triazolam	Alpha-hydroxyalprazolam, alpha-hydroxytriazolam, alprazolam, alprazolam glucuronide, bromazepem, clonazepam, diazepam, flunitrazepam, flurazepam, lorazepam, lorazepam glucuronide, medazepam, midazolam, nitrazepam, nordiazepam, oxazepam, oxazepam glucuronide, 7-amino-clonazepam, 7-amino-flunitrazepam, 7-amino-nitrazepam, temazepam, temazepam glucuronide, triazolam	Tricyclic antidepressants	Amitriptyline, clomipramine, desipramine, imipramine, protriptyline, trimipramine	Amitriptyline, citalopram, clomipramine, desipramine, doxepin, escitalopram, fluoxetine, imipramine, mirtazapine, nortriptyline, opipramol, paroxetine, protriptyline, sertraline, trimipramine, venlafaxine
Cannabis and its metabolites	THC, THCCOOH, THC glucuronide, THCOH	THC, THCCOOH, THC glucuronide, THCOH	Stimulants	Amphetamine and its derivatives (amphetamine, methamphetamine, MDMA, MDA, MDEA), cocaine and metabolites	Amphetamine and its derivatives (amphetamine, methamphetamine, MDA, MDEA, MDMA), cocaine and metabolites

Table 2
The incidence of alcohol and/or drug combinations detected in suspected DUID cases and of psychoactive substances confirmed in DUID cases.

Psychoactive substances	Number of cases	The percentage among suspected DUID cases (%) ($n = 91$)	The percentage among psychoactive substances confirmed DUID cases (%) ($n = 46$)
Only alcohol	32	35.2	69.5
Both of alcohol and psychoactive drugs	8	8.8	17.4
Only psychoactive drug(s)	6	6.6	13.1

($p < 0.05$).

injury.[2–10] It has been shown that illicit drugs (cannabis, amphetamines and cocaine, etc.) and some psychoactive drugs (benzodiazepines, etc.) impair driving skills and/or increase the risk of traffic accidents.[2,3,5–8,11,12] It has been reported that these substances decrease alertness, degrade motor skills, reduce visual acuity and cause disinhibition accompanied by an increase in risk-taking behaviour, increase of reaction time, degradation of judgement and decision-making and other effects.[13] Use of multiple drugs and/or alcohol in combination has been shown to produce a greater deterioration of driving capacity.[4,13]

Studies focussed on this subject emphasise that the incidence of drug abuse by drivers in several countries has already increased.[2,3,14–17] It has also been reported that DUID is more common than DUIA but not as well documented.[18,19]

The incidence of confirmed DUID has been described as between 1% and 4.4% for all drivers,[4,6,9,17,19] between 22% and 92.8% for drivers suspected of DUID,[6,13,19–23] 25% for drivers involved in traffic accidents,[19] between 26.8% and 81.8% for drivers injured in traffic accidents[24–26] and between 23.5% and 80.2% for drivers who died in traffic accidents.[3,4,10,16]

In recent years, most developed countries have revised DUID-related laws to enforce a zero tolerance approach in their laws.[2,20–23,27,28] In Turkey, according to the 48th sentence of the Turkish Road Traffic Law, which came into force in 1983, driving on the road under the influence of narcotics or euphoric substances or losing safe driving skills due to influence of alcohol were clearly made illegal. The regulations added to this law in 1993 emphasised that imprisonment and heavy fines will be applied for drivers under the influence of narcotics and that their driving licence will be revoked for an indefinite period. However, these imprisonments and heavy fines and revocations of driving licences for definite or indefinite periods were described in detail only for drivers who also exceeded the limits of alcohol use.[29] To compensate for this, the 179th sentence of Turkish Penal Code came into force in 2005, adding heavy imprisonments for drivers who lost their safe riding skills due to effects of alcohol or narcotics.[30] In Turkey, the blood alcohol concentration (BAC) limit for professional drivers is defined to be 0 mg dl^{-1} and 50 mg dl^{-1} for other drivers.[31] If the alcohol level is in between 31 and 100 mg dl^{-1} according to breath or blood measurements, it is accepted that the driver must be medically examined to decide about the presence or absence of safe driving skills; if the alcohol level surpasses 101 mg dl^{-1}, it is accepted that the driver has lost safe driving skills in the applications of forensic medicine and of the legal authorities.[32,33]

Table 3
Alcohol and/or drug combinations in 14 drug positive cases.

No	Drug(s)	Blood alcohol concentrations (mg/dl)
1	Cannabis metabolite (THCCOOH)	72
2	Cannabis metabolite (THCCOOH)	40
3	Cannabis metabolite (THCCOOH)	10
4	Cannabis metabolite (THCCOOH)	0
5	Cannabis metabolite (THCCOOH)	0
6	Cannabis metabolite (THCCOOH)	0
7	Cannabis metabolite (THCCOOH) + cocaine	6
8	Cannabis metabolite (THCCOOH) + MDMA + MDA	10
9	Midazolam	0
10	Midazolam + citalopram	100
11	Midazolam + citalopram + sertraline	0
12	Diazepam + nordiazepam	257
13	Pentobarbital + thiopental	175
14[a]	Pentobarbital + thiopental	0

[a] Famotidine and lidocaine were also found in this group.

Table 4
Blood alcohol concentrations of alcohol confirmed DUID cases.

Blood alcohol concentrations (mg/dl)	Number of cases	Percentage of cases
1–30	11	27.5
31–50	1	2.5
51–100	9	22.5
101 or more	19	47.5

In Turkey, 1,228,928 traffic accidents occurred in 2010, 238,074 individuals were injured and 3835 victims died in these traffic accidents. The drivers' faults were defined as the primary reason in the majority (88.4%) of these traffic accidents. The driving licences of 116,469 persons were revoked for definitive or indefinite periods because they were driving under the influence of alcohol (DUIA). However, there was not any record in the statistics about revoked driving licences due to DUID.[34] Additionally, there has not been a comprehensive study carried out on DUID and adequate traffic controls for DUID, although legal regulations have been enacted earlier than in many countries.

The aims of this study were to review the incidence of DUID among all drivers who were DUIA and/or DUID involved in traffic accidents in Istanbul and its surrounding area and to evaluate the type of psychoactive drugs (with or without alcohol) detected in blood samples of the subjects. This study is the first investigation on the subject of DUID cases in Turkey.

2. Material and methods

In this study we retrospectively reviewed the toxicology reports for alcohol and/or drugs for 1 year (from 1 July 2010 to 30 June 2011) of the Istanbul Toxicology Department of the Council of Forensic Medicine (Turkey). The toxicology reports of suspected DUIA and DUID cases involved in traffic accidents that were requested from the police traffic departments and judicial authorities were included in the study. Only the DUID reports were evaluated in detail.

Alcohol and drug analysis was performed in the Istanbul Toxicology Department according to following analysis methods:

Alcohol analysis was carried out by head space gas chromatography with dual column (HS/GC Perkin Elmer Clarus 500 GC TMHS 40, analytic columns: Elite BAC1 and Elite BAC2 (30 m × 0.53 mm) (max. 325 °C)). Psychoactive drugs were analysed using an immunoassay screening (Microgenics' CEDIA assay kits including amphetamine/ecstasy, benzodiazepines, barbiturates, Multilevel THC, cocaine, methadone, opiates and TCA Antidepressants on Hitachi 912). Following alcohol analysis and immunoassay screening all blood samples (positive or negative for drugs and alcohol) were subjected to solid-phase extraction using Oaisis HLB (60 mg) cartridges for liquid chromatography tandem mass spectrometry (LC/MS/MS) analysis. LC/MS/MS analysis was performed on a Shimadzu LC-20A series system interfaced to a MS/MS API 4000 with an electrospray Turbo V™ ion source in negative

Table 5
The incidence of alcohol and/or drug combinations reported in previous studies.

Reference	Number of cases	Location	a	b	c	d
3	3398 driver fatalities	Victoria, New South Wales and Western Australia Australia (1990–1999)	50.1	23.2	17.0	9.6
4	204 drivers fatally injured in road traffic accidents	Southeastern Norway (2003–2008)	18.7	21.1	25.0	35.2
	10,540 drivers selected in a roadside survey	Southeastern Norway (2005–2006)	94.0	0.3	2.8	2.9
6	110 injured motorists admitted to the emergency room of the hospital	Tilburg, Netherlands (from May 2000 to August 2001)	85.9	2.3	11.7	0.1
	816 controls selected in a roadside survey	Tilburg, Netherlands (from May 2000 to August 2001)	60.0	13.6	16.4	10.0
9	12,000 drivers selected in a roadside survey	Southeastern Norway (2005–2006)	95.5	0.1	4.1	0.3
10	332 drivers were killed in road traffic accidents	Norway (2006–2008)	62.2	19.9	12.8	5.1
13	641 cases submitted by the Justice Department to laboratory	Canton de Vaud, Switzerland (1982–1994)	7.2	4.8	56.3	31.7
16	1,284 blood samples of drivers were killed in traffic accidents	Denmark, Finland, Iceland, Norway, and Sweden (1991–1992)	34.0	40.0	12.0	14.0
20	4,794 DUID offenders submitted by the police or the Justice Department to the eight Swiss authorised laboratories	Switzerland (from January 2005 to December 2005)	11.0	14.0	53.0	22.0
23	440 living drivers suspected of DUID submitted by the Justice Department? to laboratory	Canton de Vaud, Valais, Fribourg and Jura, Switzerland (2002–2003)	11.4	18.0	42.6	28.0
25	414 injured drivers who presented to an urban emergency department	Colorado, USA (Undefined)	68.0	5.6	21.3	5.1

(a) The percentage of drug and alcohol negative cases; (b) the percentage of alcohol only positive cases; (c) the percentage of drug only positive cases; and (d) the percentage of both of alcohol and drug positive cases.

and positive modes. The list of drugs screened in CEDIA and LC/MS/MS is shown in Table 1.

Results were statistically evaluated by the chi-squared test. Level of significance was $p \leq 0.05$.

3. Results

In the 1-year study period between 1 July 2010 and 30 June 2011, there were 4274 toxicology reports on suspected DUI cases involved in traffic accidents.

An alcohol analysis was requested in all suspected DUI cases by police traffic departments and judicial authorities. However, the analysis of drugs as well as the alcohol was requested for only 91 (2.1%) cases. Police officers or judicial authorities did not request drug analysis in 4183 cases (97.9%). In this study, we evaluated only 91 suspected DUID cases; 4183 cases in which only blood alcohol concentration was requested were not evaluated in detail.

The evaluation of 91 suspected DUID cases, with ages ranging from 14 to 64 years with a mean age of 32.9 ± 11.7 years, showed that the vast majority ($n = 78$; 85.7%) were male ($p < 0.05$). The mean age of the male drivers (33 ± 11.8 years) was not different from that of the female drivers' (32.4 ± 12 years) ($p > 0.05$). Drivers under the age of 18 did not have a driving licence.

Unfortunately, knowledge about vehicle types involved in traffic accidents was not present in the toxicology reports and/or the documents that had been sent to the toxicology laboratory by police traffic departments and judicial authorities.

Neither alcohol nor drugs were found in the blood analysis of 45 (49.5%) suspected DUID cases; on the other hand, it was reported that, at least one psychoactive substance, alcohol and/or psychoactive drugs were detected in 46 cases (50.5%) (Table 2).

The prevalence of psychoactive drugs (with or without alcohol) was 30.4% ($n = 14$) among these 46 confirmed DUID cases and 15.4% among the 91 suspected DUID cases.

Among the 46 confirmed DUID cases, the most frequently reported psychoactive substance in the blood was ethanol (86.9%; $n = 40$), followed by cannabinoids (17.4%; $n = 8$), benzodiazepines (8.7%; $n = 4$), barbiturates (4.3%; $n = 2$), antidepressants (4.3%; $n = 2$), amphetamines (2.2%; $n = 1$) and cocaine (2.2%; $n = 1$) (Table 3). Pentobarbital and thiopental were identified in two cases. It should be kept in mind that these drugs are used during resuscitation and hospitalisation, for example following a serious traffic accident; however since we did not have the details of the cases we have not excluded them from the list.

The total incidence of all of alcohol–drug and/or drug–drug combinations was 21.7% (10 of 46 cases): 6.5% (in 3 of 46 cases) for

Table 6
The type and incidence of drugs reported in previous studies.

Reference	Sorted by frequency of drugs				
	1st	2nd	3rd	4th	Others
2	75.7% Benzodiazepines	46.0% Amphetamines	27.7% Cannabinoids	13.8% Opioids	17.3% Cocaine, barbiturates, antidepressants, antiepileptics
3	13.5% Cannabinoids	5.3% Opioids	4.8% Benzodiazepines	3.4% Stimulants	3.2% Other impairing drugs
6	12% of cases and 6% of controls, amphetamines	9% of cases and 2% of controls, cocaine	7% of cases and 3% of controls, opioids	1% of cases and 0.5% of controls, antidepressants	1% of cases and 0% of controls, methadone
13	57.3% Cannabinoids	36.3% Opioids	14.8% Benzodiazepines	10.5% Cocaine	10.3% Methadone and <5% amphetamines, barbiturates, methaqualone and other psychoactive drugs
14	39.6% Cannabinoids	3.5% Opioids	3.1% Amphetamines	3% Cocaine	–
15	12.7% Cannabinoids	5.1 % Benzodiazepines	4.9% Amphetamines	4.9% Cocaine	2.7% Diphenhydramine, 1.9% hydrocodone, 1.9% phenytoin, 1.6% morphine, 1.1% amitriptyline
16	9.9% Benzodiazepines	5.6% Amphetamines	5.2% Antidepressants	4.8% Cannabinoids	14.8% Other drugs
20	48% Cannabinoids	25% Cocaine	10% Opioids	7% Amphetamines	6% Benzodiazepines, 5% methadone, <2% antidepressants and benzodiazepines
21	33% Cocaine	33% Benzodiazepines	22% Cannabinoids	19% Opioids	14% Amphetamines, 10% methadone, 2% antidepressants, 1% barbiturates, 14% other drugs
22	64–72% Amphetamines	31–35% Benzodiazepines	25–29% Cannabinoids	20–22% Opioids	Others
23	59% Cannabinoids	13% Benzodiazepines	13% Cocaine	9% Amphetamines	9% Opioids 7% methadone
24	7.6–13.8% Cannabinoids	10.4–10.5% Opioids	1.4–2.5% Amphetamines	1.1% Cocaine	–
25	17% Cannabinoids	4% Cocaine	1% Opioids	1% Benzodiazepines	1% Propoxyphene, <4% amphetamines, methadone, meprobamate, xylene
26	46.7% Cannabinoids	15.6% Benzodiazepines	11% Opioids	4.1% Amphetamines	3% Methadone and 1% cocaine

alcohol and one drug combination, 10.9% (in 5 of 46 cases) for alcohol and two or more drugs combination and 4.3% (in 2 of 46 cases) for two or more drugs combinations without alcohol. In 8.7% (in 4 of 46 cases) there was only one type of drug in use (Table 2).

The DUID cases in which blood alcohol was confirmed ($n = 40$) are shown in Table 4.

4. Discussion

According to reports of the Toxicology Department, from 1 July 2010 to 30 June 2011, alcohol and/or drug analysis in blood samples was requested for 4274 suspected DUI cases involved in traffic accidents. The number and rate of suspected DUID cases ($n = 91$; 2.1%) was fairly low when compared with cases for which only blood alcohol concentrations had been recorded ($n = 4183$; 97.9%) ($p < 0.05$). In Turkey, the determination of breath alcohol levels in drivers involved in traffic accidents (or analysis of blood alcohol concentration in cases where drivers' objections or police officers' suspicions necessitated this) is a routine procedure, but drug analysis is not. Drug analysis is requested rarely, although the legal sanctions about DUID were well described in the Turkish laws.[29,30] Smink et al. emphasised that many cases of DUID may not be noticed due to the fact that drug analyses have been requested from toxicology laboratories only when the observations of police officers have led to a serious suspicion of drug use by the driver.[21]

In this study, suspicions of police officers or judicial authorities were confirmed in 50.5% of DUID cases involved in traffic accidents according to the toxicology reports of the toxicology laboratory of the Council of Forensic Medicine. The rates of confirmed DUID cases among all suspected DUID cases or cases involved in traffic accidents in previous studies[6,9,10,12,13,16,19–26] have been reported to range from 22% to 92.8% depending on type of sample investigated and the methods of assessment. Overall, in the study of Senna et al.[20] police observations about drivers under the influence were highly correlated with positive toxicological results.

The mean age of suspected DUID cases in our study was 32.9 ± 11.7 years, and mean age of the males (33 ± 11.8 years) was similar to that of the females (32.4 ± 12 years) ($p > 0.05$). In previous studies which were done in other European countries, the mean age ranged from 25.5 to 38.6 years for all cases: 30 years for males, 37 years for females in the suspected DUID cases.[6,13,23–25]

In the present study, the incidence of alcohol-only positive cases among all suspected DUID cases was 35.2%. The combination of alcohol and psychoactive drugs was found in 8.8% of cases, and psychoactive drug-only positive cases were 6.6% ($p < 0.05$). In various earlier studies,[3,4,6,9,10,13,16,20,23,25] the rates of alcohol and drug negative cases, alcohol-only positive cases, drug-only positive cases and alcohol and drug positive cases differ depending on the type of sample investigated and methods of assessment (Table 5).

DUID cases confirmed by blood alcohol concentrations showed levels >50 mg dl^{-1} (above the legal limits for all drivers) in 28 cases (70%). In 10 cases (25%), alcohol levels for drivers were within the range of the need for a medical examination for a decision about whether the driver had lost or not lost their safe driving skill (between 31 and 100 mg dl^{-1}); and 19 drivers (47.5%) had lost their safe driving skill (more than 101 mg dl^{-1}) according to forensic authorities' applications for legal evaluation of this subject in Turkey.[32,33] It has been reported that alcohol levels of drivers exceeded 50 mg dl^{-1} in 7.8% of cases involved in traffic accidents according to breath alcohol tests nationwide.[35] The difference between our study and the nationwide data concerning cases who have alcohol levels 50 mg dl^{-1} or above may be explained by an excess of selected cases sent to our laboratory as the result of suspicion of the police officers, and this has also been suggested by Senna et al.[20]

Psychoactive drugs were present in 15.4% of 91 suspected DUID cases and in 30.5% of confirmed 46 DUID cases. In previous studies, the presence of psychoactive drugs varied from 22% to 92.8% among drivers suspected of DUID[6,13,19–23] and from 23.5% to 81.8% among drivers involved, injured or killed in traffic accidents.[3,4,10,16,19,24–26]

In the present study cannabis was present in 17.4% of cases, benzodiazepines in 8.7%, barbiturates in 4.3%, antidepressants in 4.3%, cocaine in 2.2% and amphetamines in 2.2%. It has been reported that "there are significant variations in the type and incidence of detected drugs between jurisdictions."[3] The type and prevalence of drugs which were obtained in some studies[2,3,6,13–16,20–26] are shown at Table 6.

5. Conclusion

In the present study, the incidence of alcohol use was found to be 44% in suspected DUID cases involved in traffic accidents. Additionally, the incidence of psychoactive drug use was found to be 30.5% among 46 confirmed DUID cases and 15.4% among 91 suspected DUID cases. These results show that the incidence of alcohol and/or psychoactive drugs among drivers suspected of DUID cannot be ignored. However, whilst roadside alcohol tests are routinely applied, unfortunately roadside drug testing has not yet been implemented in Turkey. The rate of suspected DUID cases among suspected DUI cases was only 2.1%. Yet, it was reported that random roadside drug testing can act as an effective deterrent for DUID. Oral fluid samples which are properly collected for screening, and thereafter confirmed by mass spectroscopy techniques, offer a non-invasive way of random roadside drug testing in recent studies.[36–39]

Whereas the correlation of traffic accidents and the crime of DUIA cases is well described in the statistics of the road traffic accidents in Turkey, this is the first Turkish study to detect the incidence of suspected DUID cases involved in traffic accidents. These results indicate that although there are regulations, DUID is not well recognised and not inspected by police and legal authorities who are responsible in traffic accidents and routine controls in Turkey.

We conclude that, taking into account the increasing risk of injury and death associated with use of drugs by drivers in traffic accidents, psychoactive drugs should be checked along with alcohol in all traffic accident cases and roadside controls before more people are injured or killed.

Ethical approval

This study was performed by permission of the Presidency of Scientific Board of Council of Forensic Medicine.

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Authorship statement

This study was performed in cooperation with all authors.

Conflict of interest

None declared.

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